日本海域研究，第49号，67-76ページ，2018
JAPAN SEA RESEARCH, vol.49, p.67-76 2018

On Specimens of *Phreatoasellus kawamurai* (Tattersall) (Crustacea: Malacostraca: Isopoda: Asellidae) Collected from a Lava Tube in Matsue in Shimane Prefecture, Japan

Noboru NUNOMURA[1*]

Received 22 September 2017
Accepted 28 November 2017

Abstract

Phreatoasellus kawamurai (Tattersall) (Crustacea: Malacostraca: Isopoda: Asellidae) was redescribed based on specimens collected from a lava tube called "Yûkidô," in Shimane Prefecture. As a result of my examination, these specimens generally agreed with the original description, but several differences were found. Key differences included: a concaved posterior margin of pleotelson; a not remarkably short pereopod 4; the number of setae of exopod in relation to pleopod 3; numerous setae on the middle lobe of maxilla; and a not so short exopod in relation to uropod which are considered to be a geographic variation. Collecting new specimens would be difficult for the conservation of rare species such as *Luciogobius albus* (Regan), due to the danger of ground collapse. I therefore redescribed this species based on a collection from the lava tube "Yûkidô," in Shimane Prefecture.

Key Words: Asellidae, Isopoda, *Phreatoasellus kawamurai*, redescription, taxonomy

An underground-water asellid genus *Phreatoasellus* Matsumoto is characteristic in large size, blind or almost blind, pigment-less white body, having plumose 5 (not 4) setae on mesial endite on maxillula and so on.

Hitherto, ten species of the genus *Phreatoasellus* have been described as valid: *kawamurai* (Tattersall, 1921), *miurai* (Chappuis, 1955), *akyioshiensis* (Uéno, 1927), *higoensis* (Matsumoto, 1960), *yoshinoensis* (Matsumoto, 1960), *iriei* (Matsumoto, 1978), *minatoi* (Matsumoto, 1978), *uenoi* (Matsumoto, 1978), *awaensis* Nunomura, 2014 have been recorded from various parts of Japan and *Phreatoasellus joianus* (Henry and Magniez, 1991) from Korea.

Recently, I had a chance to examine a specimen collected from a lava tube called "Yûkidô" (Fig. 1), which had been collected by Mr. Hidenori Yoshigou. However it was, regrettably only a female specimen, therefore, some additional specimens including both sexes were necessary for identifying. Fortunately, some additional specimens collected by Dr. Ichitaro Niibe of Shimane University were placed at my disposal, through the courtesy of him, with the introduction of Mr. Kazunari Kadowaki. As a result of my study, these specimens agree with the original description of *Phreatoasellus kawamurai* (Tattersall), but some differences were found.

As this species may dwell only in the limited caves, collecting of new specimens is very difficult, especially, collection in this lava tube may be difficult for conservation of rare species such as *Luciogobius albus*

[1]Noto Marine Laboratory, Division of Marine Environmental Studies, Institute of Nature and Environmental Technology, Kanazawa University, 4-1 Mu, Ogi, Noto-cho, 927-0553 Japan
*Author for correspondence

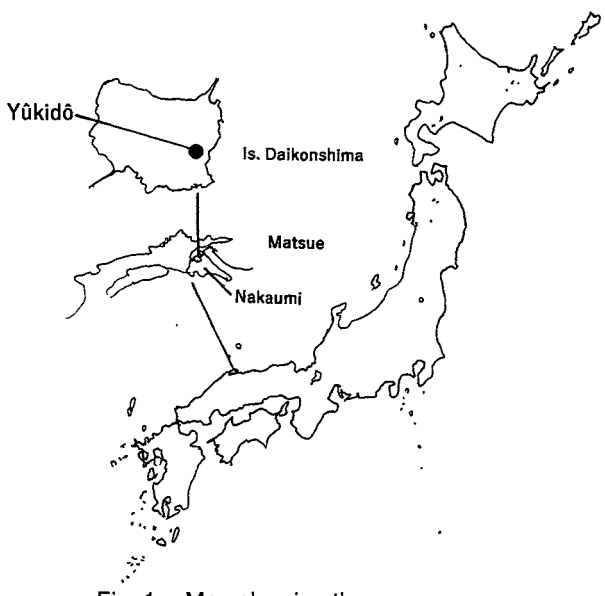

Fig. 1 Map showing the survey area.

Regan, and dangerous ground collapse. Therefore, almost all the appendages of mainly male specimens collected from this lava tube will be described.

Asellota Latreille, 1802

Asellidae Rafinesque, 1815

***Phreatoasellus kawamurai* (Tattersall, 1921)**

(Figs. 2-5)

Caesidothea kawamurai Tattersall, 1921, pp.417-419, figs. 11-18; —, Uéno, M. 1927, 360-361.

Asellus (*Phreatoasellus*) *kawamurai* (Tattersall, 1921); Matsumoto, 1962, pp.166-168, figs.1-21; —, Matsumoto, 1963, 59-63, figs.113-122.

Phreatoasellus kawamurai (Tattersall, 1921) : Nunomura, 2013, pp.54-57, figs.19-20.

Material examined: 1♂ (7.6 mm in body length) and 3♀♀ (4.5-8.0 mm in body length). Yûkidô, a lava tube, Daikonshima Island, volcanic island in the middle of Nakaumi, Matsue-shi, Shimane-ken, 28, Nov. 2004, coll. Ichitaro Niibe; 1♂(10.6 mm in body length) , same locality, 18, Nov. 2004, coll. Ichitaro Niibe; 3♂♂(7.2 -9.0 mm in body length) and 1♀(approximately 9 mm in lengt: posterior part broken), 10, Dec. 2004, coll. Ichitaro Niibe; 1♀(12.4 mm in length), same locality, 11, Apr. 2005, coll. Hidenori Yoshigou. These specimens will be deposited at Toyama Science Museum (TOYA Cr-23753~23762).

Description of male from Yûkidô. Body (Fig. 2A) slender of uniform width, about 4.5-4.8 times as long as wide excluding both antennae and uropod. Color white in alcohol. Surface smooth. Cephalon (Fig. 2E) almost 0.6 times as long as wide, without any projections. Eyes very small, each eye with 2-3 ommatidea. Pereonal somites subequal in length and almost uniform in width. Pleotelson (Fig. 2F) 1.8 times as long as wide, posterior margin with a pair of shallow concavities and small projection of medial area.

Antennule (Fig. 2B), reaching the middle area of cephalon, composed of 3 peduncular segments and 15-16 flagellar segments, many of them with 1-2 aesthetascs. Antenna (Figs. 2C and D), reaching almost the posterior end of seventh pereonal somite, with 5 peduncular segments and 44-71 flagellar segments in male. Left mandible (Fig. 3A): pars incisiva 5-toothed; lacinia mobilis 2-toothed; 11-12 serrated setae; palp three-segmented; segment 2 as long as segment 1, with 6-20 setae on distal half; terminal segment with 8 -20 short setae on inner margin. Right mandible (Fig. 3B): pars incisiva 5-toothed; 11-15 serrated setae; palp as left one. Maxillula (Fig. 3C): mesial lobe with 5 plumose segments, two of them shorter than the others; lateral lobe with 12 teeth at the tip, five of them serrate and shorter three. Maxilla (Fig. 3D): mesial lobe with 18 serrated setae and 24-30 setae; middle lobe with 24-30 and lateral lobe with 30-33 setae. Maxilliped (Fig. 3E): endite with 6 coupling hook on lateral margin; palp five-segmented, second segment biggest, with 15-16 setae on inner margin and 3 setae on margin; third segment square with setae on inner margin and more than 15 setae on inner margin; fourth segment slender, with 2 setae, fifth segment with more than 21-23 setae around the margin; epipodite wide and almost triangular, with 15-17 setae around margin.

Pereopod 1 (Fig. 4A): basis about twice as long as wide, with 5-6 setae on inner margin and 2-4 setae at inner distal angle and 2 setae on outer margin wide; ischium two-thirds as long as basis, with a seta on inner margin and 2 setae on outer margin; merus trapezoid,

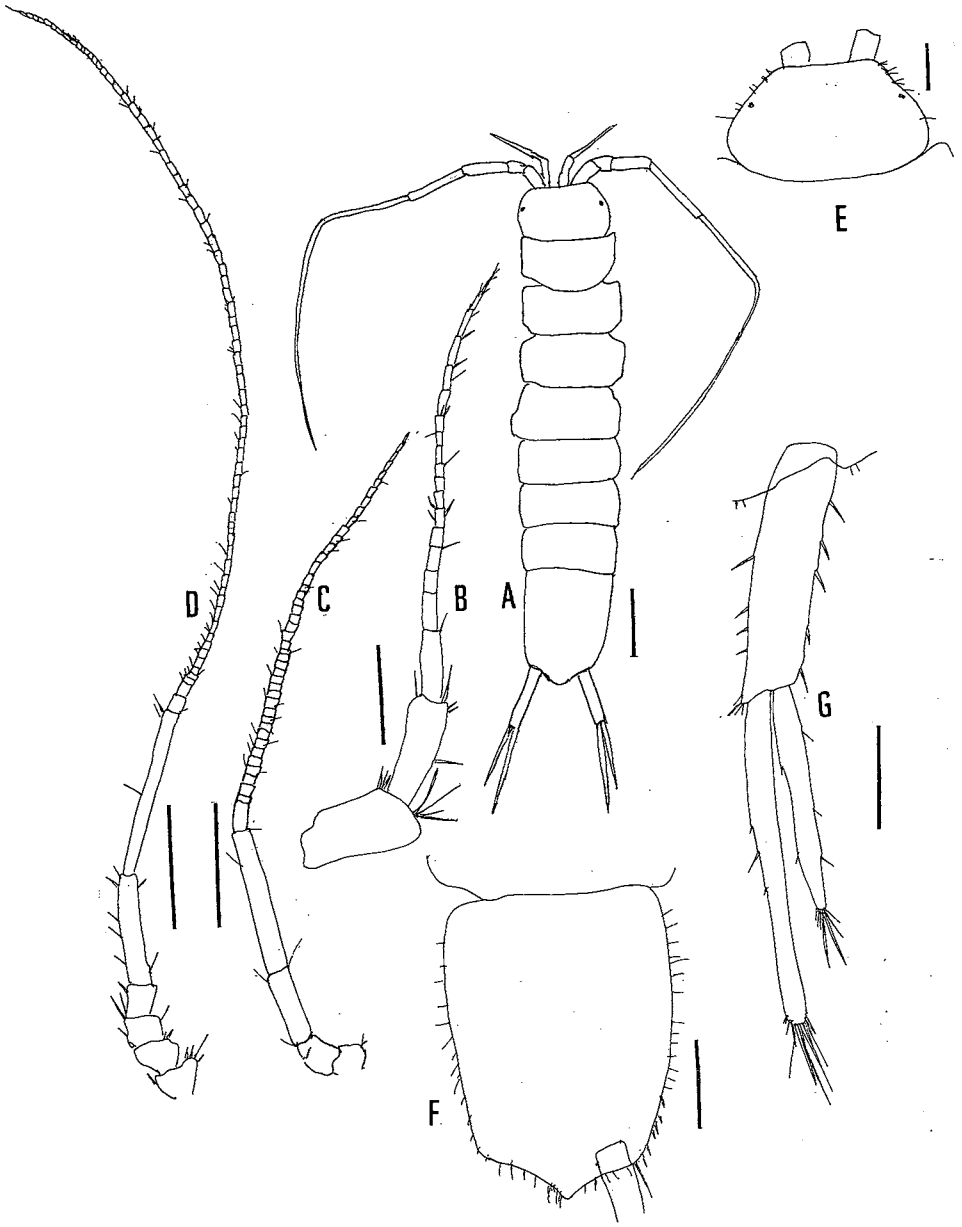

Fig. 2 *Phreatoasellus kawamurai* (Tattersall, 1921)
A: Dorsal view of whole body in male, B: Antennule of male, C: Antenna of male, D: Antenna of female, E: Cephalon of the same, F: Pleotelson of the same, G: Uropod. Scale bars: A, C, D = 1.0 mm, B, G = 0.3 mm, F = 0.5 mm.

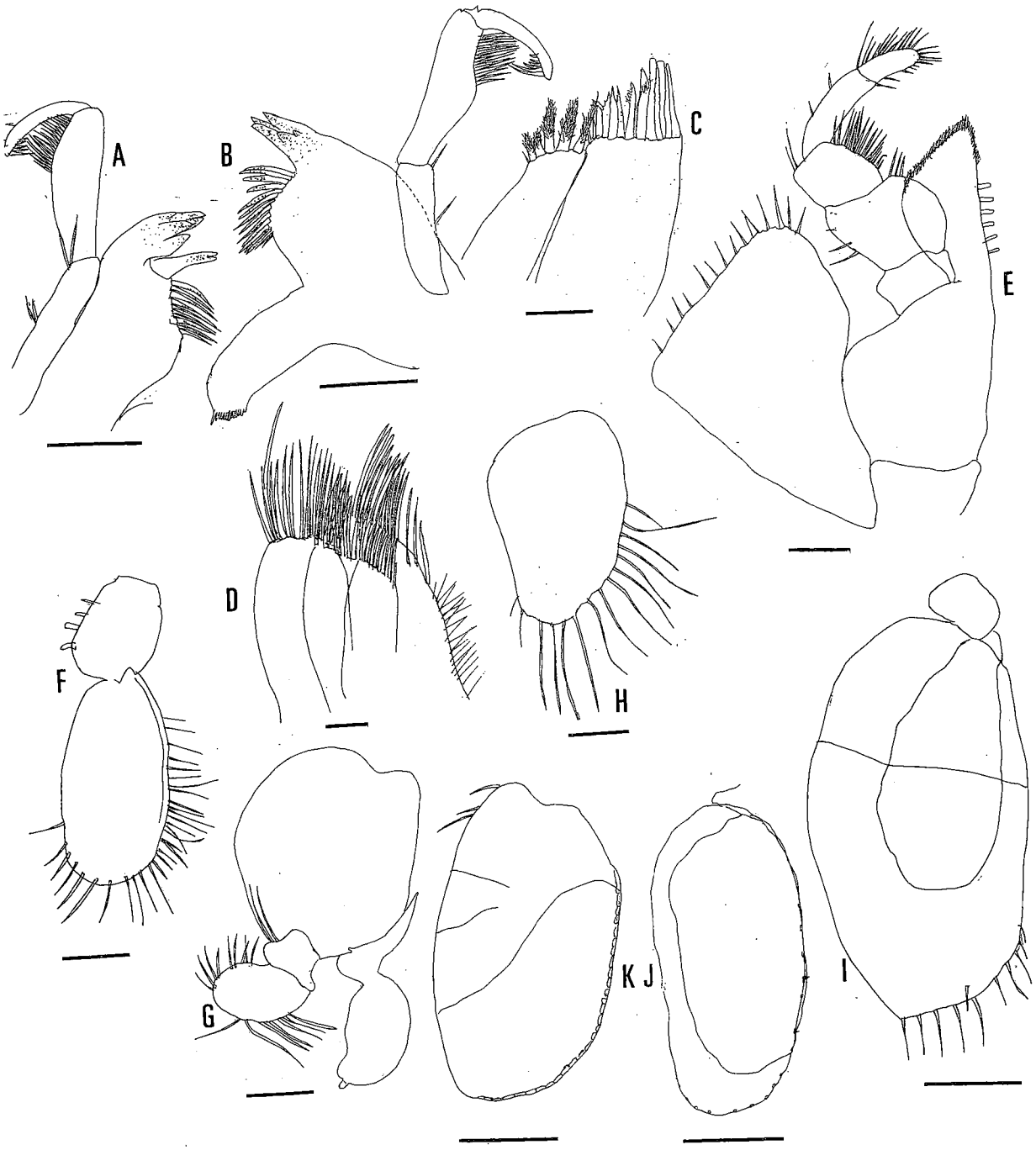

Fig. 3 *Phreatoasellus kawamurai* (Tattersall, 1921)
A: Left mandible, B: Right mandible, C: Maxillula, D: Maxilla. E; Maxilliped, F: Pleopod 1 in male, G: Pleopod 2 in male, H: Pleopod 2 in female, I: Pleopod 3, J: Pleopod 4, K: Pleopod 5. Scale bars: A, B, E, F = 0.2 mm, C, D = 0.1 mm、H-J = 0.5 mm (A-G, I-K male, H: C, D = 0.1 mm、H-J = 0.5 mm (A-G, I-K: male, 7.6 mm in body length H: female 12.4 mm in body length).

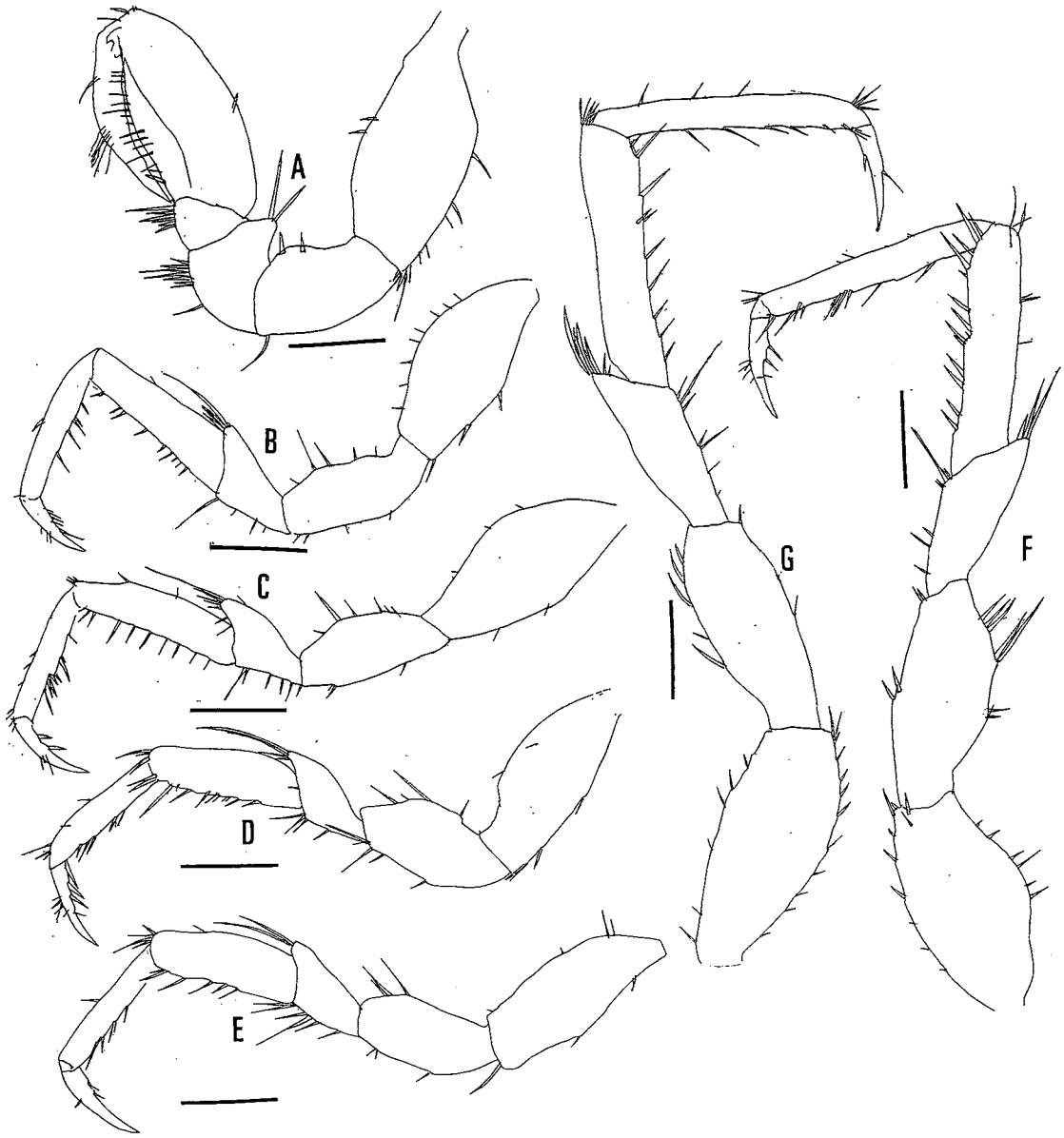

Fig. 4 *Phreatoasellus kawamurai* (Tattersall, 1921)
A-G: Pereopods 1-7 in male. Scale bars: A-G = 0.5 mm

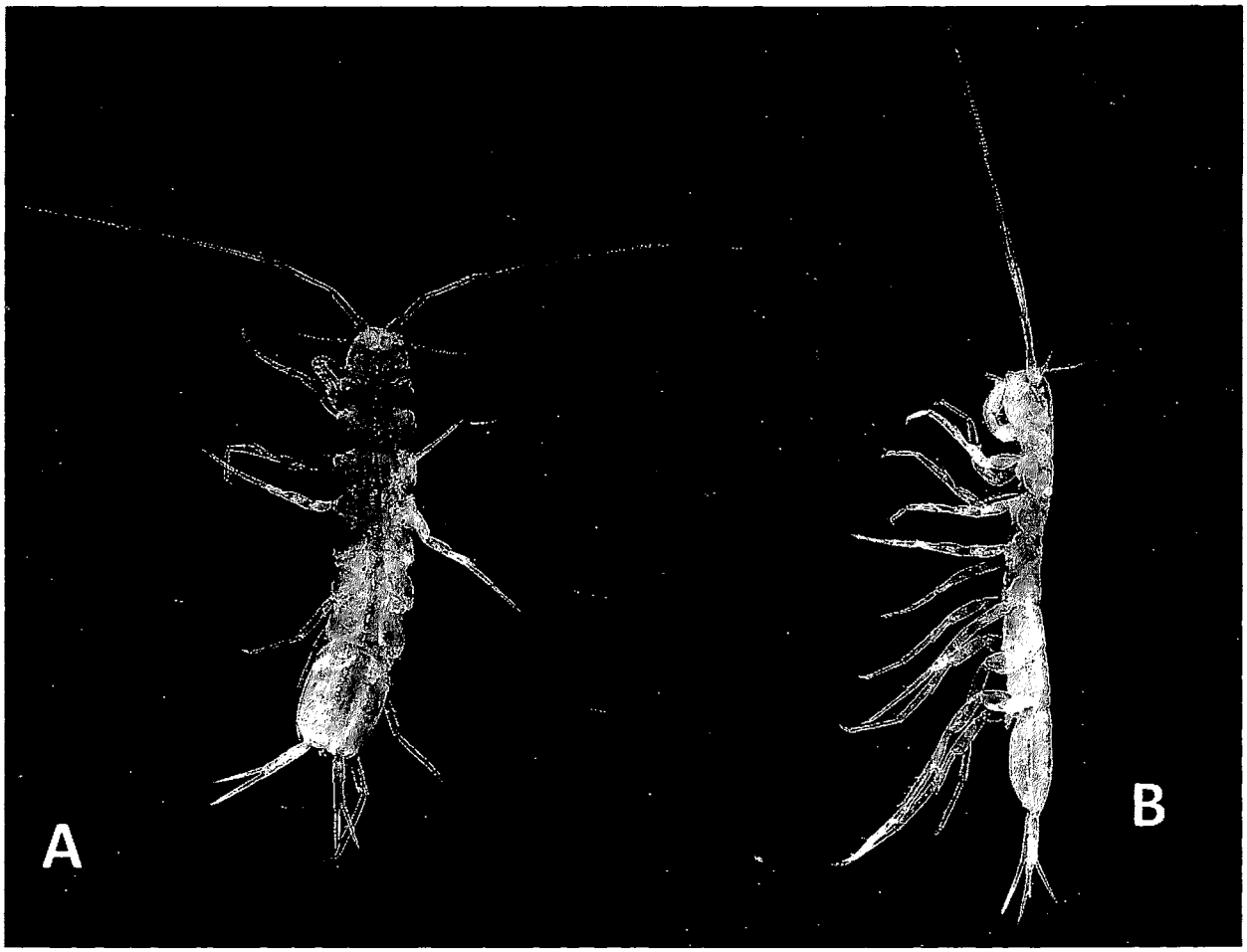

Fig. 5 Dorsal view of female of *Phreatoasellus kawamurai* (Tattersall, 1921)
A: Dorsal view, B: Lateral view (body length 12.4 mm; photo taken by Mr. Hidenori Yoshigou).

with 7 setae on inner margin and 2 setae at outer distal angle; carpus triangular, with 6 setae on inner margin; propodus about 3 times as long as wide, with 15- 17 setae on inner margin and 3 setae at outer distal angle; dactylus as long as propodus, with 10-11 setae on inner margin, with a group of 7-8 spine-like setae on distal outer margin.

Pereopod 2 (Fig. 4B): basis 3 times as long as wide, with 3 setae on inner margin and 8-10 setae on outer margin; ischium three-fourths as long as basis, with 4-8 setae on inner margin and 5-6 setae on outer margin; merus 55 % as long as basis, with 4-5 setae on inner margin and 4 setae including a long one at outer distal margin; carpus 1.9 times as long as wide, with 10 short setae on inner margin and 1-3 setae on outer margin ; propodus 0.8 times as long as carpus, with 3-5 setae on inner margin and 1-2 setae on outer margin; dactylus one-third as long as propodus, with 4-5 spine-like setae on inner margin.

Pereopod 3 (Fig. 4C): basis 2.4 times as long as wide, with 2-6 setae on both margins; ischium two-thirds as long as basis, with 3-4 setae on inner margin, 6-7 setae on outer margin; merus short, 0.6 times as long as ischium, with 6-7 setae on inner margin and 4-6 setae including a long one on outer distal area; carpus 2.5 times as long as merus, with 8-10 setae on inner margin and 2 setae on distal margin and about 4-5 short setae at outer distal angle; propodus 0.7 times as long as carpus, with 7-8 setae on inner margin and 5-6 setae on outer margin; dactylus two-thirds as propodus, with 2 spine-like setae on inner margin and a group of 5-6 setae.

Pereopod 4 (Fig. 4D) 95% as long as pereopod 3: basis 2.4 times as long as wide, with 3-6 setae on inner margin and 1-10 setae on outer margin; ischium three-fourths as long as basis, with 3-7 setae on inner margin and 4-6 setae on outer margin; merus 0.8 times as

long as ischium, with 5-6 setae on inner margin and 4-6 setae a including a long one at outer distal angle; carpus 1.8 times as long as merus, with 10-13 setae on inner margin and 5 setae on distal margin; propodus 0.9 times as long as carpus, with 8-9 setae on inner margin and 6-10 setae on outer margin ; dactylus one-third long as propodus, with 3-4 spine-like setae on inner margin and 5-6 setae on distal part of outer margin.

Pereopod 5 (Fig. 4E) a little longer than the four preceding pairs: basis twice as long as wide, with a long seta at inner distal angle, 2 setae on inner margin and 3-4 short setae on outer margin ; ischium 0.8 times as long as basis, with 4-5 setae on inner margin and 3 setae on outer margin; merus half-length of ischium, with 5-7 setae on inner margin and 2 long setae at outer distal angle; carpus twice longer than merus, with 6-7 setae on inner margin and 5-7 setae at outer distal angle; propodus 0.9 times as long as carpus 4-5 times as long as wide, with 4 setae on inner margin and a seta on outer margin; dactylus one-third as long as propodus, with 2-3 spine-like setae on inner margin.

Pereopod 6 (Fig. 4F): basis elliptical, with 8-10 setae on inner margin and 6-7 setae on outer margin; ischium almost as longer as basis, with 3-6 setae on inner margin and 4-8 setae on outer margin; merus 0.6 times as long as ischium, with 5-6 setae on inner margin and 3 setae at outer distal angle; carpus about twice longer than merus, with 8-14 setae on inner margin and 6 setae on outer margin; propodus long 0.9.3 times as long as carpus, with 6-10 setae on inner margin, 1.9 times longer than 7-8 short setae on outer margin and a spine on distal margin; dactylus one-fourth as long as propodus, with 2 spine-like setae on inner margin and 5-6 setae on outer margin.

Pereopod 7 (Fig. 4G): basis with 9-12 setae on inner margin and 6-8 setae on outer margin; ischium almost as long as basis, with 2-4 setae on inner margin and 5-6 setae on outer margin; merus 0.7 times as long as ischium, with 6-7 setae on inner margin and 7 setae at outer distal angle; carpus 1.8 times as long as merus, with 5-10 setae on inner margin and 4-5 setae on outer distal angle; propodus a little longer than carpus, with 7-8 setae on inner margin, 3 setae on outer margin and 4-6 setae at outer distal angles; dactylus 0.8 times as long as propodus, with 1-2 spine-like setae on inner margin and a seta on outer margin.

Pleopod 1 (Fig. 3E): sympod 1.4 times longer than wide, inner border with 4 hook-like protuberances; exopod ovoid, with 29-33 setae around the margin.

Pleopod 2 (Fig. 3F): sympod rectangular, a little longer than wide; endopod rectangular, 2.5 times as long as wide, with long horn-shaped basal apophyse extending toward the inner margin of peduncle and a small protuberance at the tip; exopod 2-segmented, basal segment pentagonal, with 3 setae, terminal segment elliptical, with 15-19 setae around the margin.

Pleopod 3 (Fig. 3H): endopod ovate; exopod rectangular and larger than endopod, twice as long as wide, with a transverse suture line and 9-14 setae on basal area of outer margin.

Pleopod 4 (Fig. 3I): rami elliptical, endopod elongated, exopod with S-shaped suture line and 3 setae on basal part of outer margin.

Pleopod 5 (Fig. 3J): both rami elongated, but shorter than pleopod 4.

Uropod (Fig. 2G) long and occupied about 28-33 % of the whole body and twice as long as pleotelson; sympod occupies of 60 % of whole uropod length, with 5-6 setae on inner margin and 6 setae on outer margin; endopod three-fifths as long as basis, with 3 setae on both margins and a tuft of 5-6 setae at the tip; exopod 0.7 times as long as endopod, with 2 setae on inner margin, 3 setae on outer margin and a tuft of 5-6 setae at the tip.

Female: Body (Fig. 5) 4 times as long as wide. Antenna with 72～80 flagellar segments. Total length of pereopod about 98 % as long as pereopod 3. Pleopod 1 semicircular. Pleopod 2 lanceolate, with 16 setae around the tip. Uropod not so long as male: occupied about 22 % of the whole body and as long as pleotelson. Other feature similar to male. Other features are as male.

Habitat: Specimens were collected mainly from the shallow rocky bottom with mud, near entrance, mainly shallower than 10 cm in water depth.

Remarks: The specimens examined in this study are identified to be *Phreatoasellus kawamurai* (Tattersall). Though the original description of this species did not

refer to every appendage. After that, Uéno (1927), Matsumoto (1961), Matsumoto (1962), Matsumoto (1963) referred and figured some appendages. Recently, Nunomura (2013) redescribed this species based on the specimens from Matsuyama, Shikoku and pointed out several differences from these papers. I found not a few differences among the above-mentioned descriptions.

Among these differences, length the ratio of body length to body width, relative length of uropod, number of flagellar segments is considered to be changeable according their age. As to the number of coupling hooks on male pleopod and number of coupling hooks of maxilliped, the possibility of the individual variation is higher. Whereas, the following features are considered to be geographically characteristic variation, because the features are stables in the present specimens: (1) presence of a pair of concavities on the posterior margin of pleotelson (entire in original description), (2) not remarkably shorter pereopods 4 (ratio of total length of pereopod 4 to pereopod 3 in original description 95～98 %, but 82 % in the Matsumoto's report (1963), (3) more numbers of setae exopod pleopod 3 (up to 14 in the present specimens, whereas 9 in original description and Matsuyama specimens), (4) numerous setae on middle lappet of maxilla (24-30 in the present specimens, whereas 16 in Matsuyama specimens, not reported in original description), (5) relatively longer exopod of uropod (more than 0.70 in the present specimens, whereas about 0.55 in original description and 0.33 in Matsuyama specimens) and (6) less numerous inner spine-like setae on dactylus of pereopod 1 (10-11 in the present specimens and 12 in the original description, whereas 15-16 in Matsuyama specimens).

As explained-above, this species has unremarkable but not a few geographical variations. These may be because their inherent lack of dispersal ability and lack of dispersal ability of isolation.

Acknowledgment: I would like to express my sincere gratitude to Dr. Ichitaro Niibe, Faculty of Life, Environmental Science, Shimane University, for his kindness in placing the important material at my disposal, to Mr. Hidenori Yoshigou, Chugai Technos Corporation, in his kindness in giving chance to examine the first specimens and photos, and to Mr. Kazunari Kadowaki of Shimane Prefecture Nature Observation Instructor for his kindness in arrange the introduction of Dr. Niibe's collection for the present study.

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島根県松江市大根島の熔岩洞から発見されたナガミズムシ *Phreatoasellus kawamurai* (Tattersall)（甲殻類，等脚目，ミズムシ科）の標本について

布村　昇[1*]

2017年9月22日受付
2017年11月28日受理

要　旨

島根県松江市の大根島は島全体が火山で，主に玄武岩の溶岩からなるが，溶岩が流れる際にできた熔岩隧道である幽鬼洞から発見されたナガミズムシ属（甲殻亜門，軟甲綱，等脚目，ミズムシ科）の標本を調査したところ，*Phreatoasellus kawamurai* (Tattersall)と同定された。しかし，原記載や従来報告された幾つかの報告との形態的相違が見つかった。そのうち，腹部節後端に1対の浅いくぼみがあること，第4胸脚が第3胸脚に比して著しく小さくはないこと，尾肢が比較的短いこと，第2小顎の基節内葉の剛毛数や第3腹肢外肢の剛毛数が多いこと，第1胸脚指節内縁の棘の数が少ないこと，尾肢外肢の長さが内肢に比して著しく短くないことなどは地理的変異と考えられる。なお，顎脚の交尾鉤数やオス第1腹肢基節の交尾鉤数などは個体により変異があるようである。そのほかの変異は成長の変化に伴って変化する形質である可能性が高い。なお，この隧道はドウクツミミズハゼのなどの貴重種が生息しており，崩落の危険があるため入洞は禁止されており，今後も多くの標本を採集することは困難であると思われるので主に分類形質として必要となる可能性の高いオスのほとんどの付属肢の形態を記載しておく。

キーワード：ナガミズムシ，ミズムシ科，等脚目，再記載，分類

[1]金沢大学環日本海域環境研究センター研究領域部門海洋環境領域臨海実験施設　〒927-0553 石川県鳳珠郡能登町小木ム4-1
[*]連絡著者